THE ASPHYXIAL FACTOR IN ANÆSTHESIA

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THE ASPHYXIAL FACTOR IN ANÆSTHESIA

And Other Essays.

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To

DR. FREDERIC W. HEWITT

IN GRATEFUL RECOGNITION

OF HIS TUITION

AND MANY ACTS OF KINDNESS

PREFACE

THESE pages are intended to offer a slight contribution to the study of surgical anæsthesia, and to record some of the principles and methods upon which experience has taught me to set the greatest value.

From the point of view of one who has opportunities for testing the methods by constant use, I venture to write these chapters for the service of those whose field of work is larger than my own, but to whom the occasional administration of an anæsthetic is a matter for anxious consideration.

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PART I

THE ASPHYXIAL FACTOR IN ANÆSTHESIA

It is the object of this essay to direct attention to numerous causes which tend towards the production of an asphyxial element during surgical anæsthesia, for it is my belief that if these were generally detected and eliminated as they arose, it would result in a far higher level of safety to patients under the influence of nitrous oxide, ether, and chloroform than the use of apparatus designed with the idea of preventing overdosage, or even the application of the remedial measures usually relied upon when a condition of danger has become pronounced.

The physiological effects of asphyxia in man should be closely studied by those who wish to become proficient administrators; because it is necessary to be intimately acquainted, not only with those symptoms

which precede the appearance of asphyxia arising in an acute form, but more especially with those subtle phenomena which supervene when a process of more gradual deoxidation of the blood is at work within the patient's system.

The early perception of even very slight degrees of anoxæmia, and a knowledge of the proper methods of eliminating this factor, are among the most important accomplishments of the anæsthetist: for he should very clearly bear the fact in mind that, during anæsthesia, a condition in which oxygen is not gaining access to the system in adequate amount is fraught with very real danger to life in two distinct directions.

Firstly, because the respiratory centre in the medulla is primarily stimulated, and afterwards depressed, by the action of an anæsthetic in the blood; and being also similarly affected by a state of anoxæmia, is therefore far more readily reduced in vitality by the two influences combined than by the former influence acting alone.

Secondly, particularly under chloroform, because of the rapid supervention of secondary cardiac dilatation and paralysis, when the cavities of the auricles and ventricles are laden with a drug which weakens their contractions, if the coronary vessels

which nourish them are at the same time filled with venous blood.

The progressive stages of asphyxia which are to be observed in the human being when some exciting cause is at work during the waking state are hardly to be expected, and do not as a fact exhibit themselves in any marked degree, when ether or chloroform has been added to the circulating fluids.

The appearance of hyperpnœa, dyspnœa, general convulsions, gradual exhaustion, and death, in ordinary conditions of disease, are apt, in anæsthesia, to be represented by laboured breathing, which grows shallow and irregular, and is followed by complete and sudden cessation of respiration, with cardiac failure in close attendance.

In the narcotic state general convulsions are exceedingly rare, and, unless the asphyxia be quite rapidly produced, such as by an overdose of nitrous oxide gas, they are not to be looked for during the production of an asphyxial death. It is possible, however, that slight clonic muscular movements of the shoulders and arms which sometimes occur in very profound chloroform narcosis, and also that which has been described as an athetoid movement of the fingers and wrist-joints, and occasionally also of the eyelid and eyeball, may be of asphyxial origin,

for they only precede respiratory failure by a very short interval.

Muscular rigidity, which under some circumstances is also a symptom of anoxæmia, is commonly witnessed during the second stage of anæsthesia under ether and chloroform, when a transient tonic contraction of the musculature occurs, which develops into a state of opisthotonos if air is not admitted to the lungs. Accompanied as it is by cyanosis, when this condition arises, the need for oxygen should be quite obvious even to the beginner.

The most important observation of all is that of the significance of the behaviour of the respiratory system in the narcotic state, and this must be thoroughly mastered before it can be confidently stated that no asphyxial factor, which will complicate the simple action of the anæsthetic, is at work at any given moment of the administration.

The exact import of *rapid breathing* under an anæsthetic depends upon the stage at which it occurs. In the first and second stages of anæsthesia it is generally a voluntary effort caused by nervousness on the part of the patient; but if it should appear in the later phases of the third stage, it may be looked upon as representing the hyperpnœic condition associated with a need for more air and

less of the anæsthetic, the differentiation of these stages depending upon the presence or absence of the corneal reflex at the time of its appearance.

It is commonly witnessed in cases with pyrexia, and I have noticed it also especially in the subjects of hepatic abscess.

Deep breathing is the usual accompaniment of deep anæsthesia, and as long as it proceeds regularly and does not keep increasing in depth, or the amplitude of chest movement is not exaggerated, is the safest type of respiration to maintain. The two provisional conditions just mentioned must, however, be strictly observed, for when an asphyxial factor has been introduced, increasing depth of respiration is the first reflex effort of the respiratory system to obtain sufficient oxygen, and exaggerated thoracic and abdominal movement will be its outward manifestation. Deep breathing may also be caused by powerful stimulation of afferent nerves on the part of the operator, such as may be produced by stretching the sphincter ani, dilating the urethra or the cervix uteri, dragging on the peritoneum or spermatic cord, or by interference with old-standing disease of large joints.

Shallow breathing is most commonly to be witnessed under chloroform, and is frequently accom-

panied by pallor. It is sometimes dependent upon too light a form of anæsthesia with impending vomiting; but in deeper stages of anæsthesia, when corneal reflex is almost or quite abolished, shallow breathing is a sign of approaching paralysis of the medullary centre.

The pallor which accompanies this kind of respiration is largely due to the lessened suction action of the feebly moving thorax upon the heart and venous system. That strong thoracic movement is a powerful factor in emptying the large veins, I have frequently observed in witnessing operations which expose the internal jugular vein at the root of the neck, when this vessel is seen to partly flatten at each cardiac diastole during expiration, but to collapse completely during deep inspiration.

Shallow breathing should not, therefore, be permitted to continue; but either by rubbing the lips, which reflexly stimulates respiration, and deepening the anæsthesia in the early stages, or, in the deeper stages, by withholding the anæsthetic, and making regular pressures upon the sternum till a more ample thoracic movement is produced, deeper automatic respiration can be established and should afterwards be maintained.

Irregular breathing is of very grave significance,

and, excepting in the early stages before automatic regular respiration has set in, must be regarded also as a sign of impending central failure, and treated by withdrawal of the anæsthetic and careful supervision of the freedom of the airway.

With this knowledge, variations in the rate and rhythm of the respiratory act should render valuable information as to the condition of the blood at any period of the anæsthesia. Other early signs of the presence of an asphyxial factor are dependent upon commencing congestion of the venous system, and will be observed in alteration of the colour of the ears, which often look slightly bluish before any change is perceptible in the appearance of the lips or cheeks; in perspiration of the forehead and scalp, and in any undue oozing of blood from the operation wound, where changes in oxygenation can also be readily detected by the administrator.

With regard to congestion of the cutaneous and membranous surfaces produced by the presence of an asphyxial factor in the blood, it is well to bear in mind that the respiratory tract especially is prone to engorgement arising from such a cause, and that this engorgement will further aggravate the condition of anoxæmia by presenting mechanical obstruction to the ingress of air owing to the resulting

increase in size of the mucous lining of the air-passages, and of the tonsils, tongue, and other neighbouring structures.

When this occurs further obstruction then develops from the presence of an increased amount of mucus secreted by these congested surfaces, and beyond this, again, the presence of mucus in the upper air-passages often causes some degree of laryngeal spasm, after which complete occlusion of the airway is very soon an accomplished fact.

In this manner it is frequently the case that true anoxæmia, evidenced only by slightly faster and deeper breathing, with a slight wheeze or mucous crepitation during inspiration, and slight duskiness of the ears, arises under an anæsthetic, but unfortunately passes unnoticed until one of the grosser forms of the asphyxial factor is added for a few seconds either by posture, by the operation, or by reflex closure of the glottis. At this juncture respiration ceases suddenly, the dilated heart fails immediately, and 'a death from syncope' is reported, which is, in fact, nothing else than a death from an increasing asphyxial element, which it should have been the administrator's first duty to discover and prevent.

I have observed this neglect of the asphyxial

factor in anæsthesia week by week and year by year in watching the administration of anæsthetics by students, and by others also who have greater responsibility in this matter, and am convinced of the futility of teaching dosimetric methods until the malignant influence of asphyxia in anæsthesia is thoroughly understood and appreciated.

The foregoing remarks are intended to direct attention towards a slighter and more subtle degree of asphyxia than that which is generally recognised as such; but I believe that we shall not be treading on too familiar ground if I pass in review the various conditions under which the grosser forms of asphyxia may arise, for they are frequently the *fons et origo* of unexplained difficulty in the administration, embarrassment to the operator, and danger to the patient's life.

Let us first, then, turn to consider the pathological conditions of the brain and nervous system, blood, heart, pulmonary alveoli, bronchi, trachea, tongue, jaws, and teeth, and of the accessory sinuses of the upper air-passages, which may introduce an asphyxial element into the otherwise healthy system.

The respiratory centre in the medulla is liable to depression of function in the presence of tumours, hæmorrhages, and abscesses, within the cranium;

as a rule, the interference with respiration will arise from pressure transmitted to the medulla from the seat of mischief, and when the tension in the latter has been removed by operative procedures, danger from that particular form of respiratory failure is at an end; but it must be pointed out that so subtle is the danger of respiratory failure in anæsthesia in such cases, while the tension exists, that it is quite possible for such a patient, passing well through the early stages of narcosis, at any moment to cease breathing, owing either to a slight rise in general blood-pressure, which increases the local tension, or even from the most trifling alteration in the posture of the head, causing that exact amount of intracranial tension which will extinguish the vitality of the respiratory mechanism. Artificial respiration must be immediately resorted to, and maintained till the operator can remove the cause of danger.

If a patient be partly under the influence of morphia, and breathing ceases during general anæsthesia with chloroform or ether, owing to the involatile nature of the morphia and its depressant action upon the medulla, artificial respiration will have to be prolonged and vigorous in order to aërate the blood and eliminate the anæsthetic before automatic respiration is re-established, and this will

only be effectual if the dose of morphia has not been sufficient of itself to paralyze the centre in question.

Primarily owing to reduction in the amount of hæmoglobin in the blood in general anæmia, this condition conduces to the appearance of symptoms of deoxidation earlier than in the normal subject under all anæsthetics; but such symptoms are especially noticeable in anæmic patients under the influence of nitrous oxide gas, when stertorous breathing, cyanosis, and jactitation develop more rapidly than usual, and the resulting duration of anæsthesia, which depends to some extent upon the total quantity of gas which can be absorbed and the absence of violent respiration, is very short when the facepiece is removed for dental extractions.

Fatty degeneration of the heart, or muscular feebleness of its walls due to other causes, produces an asphyxial element during narcosis by allowing accumulation of venous blood in the lungs, and possibly also by producing anæmia of the respiratory centre in the medulla.

A slightly dusky appearance of the veins of the face and nose before anæsthesia, with a history of dyspnœa on slight exertion, should place the anæsthetist on his guard for the appearance of further evidences of this morbid condition, which it is

almost impossible to recognise definitely with the aid of a stethoscope.

Mitral stenosis and regurgitation, by their ever-present tendency to produce pulmonary stasis and engorgement of the venous side of the circulation, are to be reckoned with quite as much from the respiratory as from the cardiac point of view in anæsthesia.

On the other hand, in aortic valvular disease symptoms of failure during narcosis are primarily syncopal in character.

Emphysema, and all conditions tending to impair the mobility of the chest wall, including intercostal muscular paralysis, delay the interchange of gases in the blood by the absence of normal thoracic suction upon the circulation and by concomitant mechanical distension of the air cells. The subjects of this condition, and those in whom old pleuritic adhesions often produce the same effect, are apt to grow dusky under an anæsthetic, and to remain so for an appreciable time after its withdrawal.

Acute or chronic bronchitis retards the entrance of air and oxygen owing to the blocking of the bronchioles, the presence of mucus, and a tendency to cough and straining which hamper the respiratory rhythm in this disease.

In addition to these moderately severe asphyxial factors, persons suffering from pneumonia and phthisis present a definitely reduced area of available lung tissue, rendering them exceedingly unfavourable subjects for surgical anæsthesia; and it will always be wise to use the blandest and least irritating vapour, by that method which allows the admixture of the largest quantities of air, if anæsthesia in such patients becomes for any reason absolutely essential.

Empyema also greatly increases the risk of asphyxial complications in anæsthesia by limiting chest movement; if on the left side, sometimes also by displacing the heart, and by diminishing the area of working lung tissue as well; but the most prominent danger in this disease and in cases of lung abscess is the chance of communication between the abscess cavities and the bronchi. This possibility should always be present in the administrator's mind, and should make him insist that the sound side of the patient's chest be continuously kept above the level of the diseased one, in order to prevent the pouring out of pus or blood from the bronchus of the affected side, and its inhalation into the bronchus of the opposite and healthy lung.

Fatal accidents have occurred in this manner,

and, as they are avoidable by arranging the posture of the patient beforehand with the operator, should not happen when this particular danger has been recognised. It is often, in my experience, best to turn the patient over almost on to his face, with the diseased half of the chest lowermost; for it will then be found that the operator can obtain an excellent site for his incision from the latero-dorsal aspect of the patient's thorax, and can complete his work without any subsequent disturbance of that posture from beginning to end of the operation.

The presence of mucus, blood, or pus in the respiratory passages, or the possible access of any other fluid to the lungs or airways, will render great caution necessary during anæsthesia; for, in order to remove these causes of asphyxial complication, the administrator must immediately detect their presence and exact situation with certainty, and promptly adopt one of the measures presently to be described.

Aneurisms of the aorta or of the bloodvessels in the neighbourhood of the trachea, and enlarged mediastinal glands or other tumours within the thorax, may produce a narrowing of the trachea, which during anæsthesia may be sufficient to endanger life from asphyxia, and, seeing that such

causes are not within the possibility of removal, patients with such diseases are very likely to succumb to the influence of a general anæsthetic. The exact amount of dyspnœa and obstruction which is exhibited on deep inspiration before narcosis is, of course, the proper guide as to whether anæsthesia can be attempted in any particular instance; but the fact must not be lost sight of that the patient may be only keeping himself alive by powerful and continuous voluntary efforts of respiration, and that when these have been abrogated by the influence of chloroform the automatic mechanism may not be sufficient to prevent asphyxia from ensuing.

If the patient can sleep for more than a few minutes at a time, anæsthesia is generally possible in skilled hands; but if his natural sleep is constantly broken by the onset of obstruction, anæsthesia is highly dangerous, and will almost certainly be fatal, unless, as will be pointed out later on, the operator can open the trachea or otherwise mechanically relieve the obstruction at a moment's notice.

The involvement of the recurrent laryngeal nerve in a growth or aneurism not otherwise producing asphyxial symptoms from pressure, by paralyzing the vocal cord, may, however, cause quite as serious

a diminution of the laryngeal opening as by pressure from without.

Intubation of the larynx during anæsthesia has, in my hands, successfully overcome this difficulty; but, in the absence of appropriate apparatus, tracheotomy may become necessary in such a case to save the patient's life.

It will be suitable here to mention enlargements and cysts of the thyroid gland, which often cause very grave difficulties in the anæsthesia during their removal. The trachea is often pressed upon for some inches of its length, and the rings may have to some extent become softened and absorbed as a result. Here, if the case is at all a severe one, I consider there is a distinct and appropriate opportunity for the employment of a local anæsthetic during the initial incisions until the tension upon the trachea is somewhat reduced, and, in fact, until tracheotomy becomes possible if asphyxia were to supervene. Chloroform can then be safely given for the remainder of the operation.

Angina Ludovici, or cellulitis of the neck, also offers great risk from asphyxia, by the likelihood of engorgement of the already inflamed tissues under an anæsthetic and a consequent rise in tension of these parts, which may then entirely occlude the airways.

Chloroform or the A.C.E. mixture are the only permissible anæsthetics in such cases, as nitrous oxide or ether will certainly add to the local congestion.

Where inflammations and growths are present within the larynx, and also in cases of paralysis of the vocal cords, tracheotomy is commonly resorted to in the initial stages of the operation; but the commencement of the inhalation of chloroform is not devoid of risk; on the other hand, however, experience teaches that the danger of central respiratory failure, secondary to obstruction of the airway, is diminished when the disease is of a chronic nature, because in such patients a compensatory amplitude of thoracic expansion has been established, and, having been continuous, is also well-nigh automatic in nature, and is not therefore so liable to failure and cessation as in the case of obstructions which are more acute in onset.

Spasm of the larynx, though not to be accurately described as a pre-existing pathological condition, is yet so much more liable to happen as a reflex to the introduction of narcotic vapours in those patients whose respiratory apparatus is in any way at fault, that I purposely place it in this particular sequence, in order to carry out my plan of endeavouring to

present the reader with a series of consecutive mental pictures of the mechanical asphyxial aspects of the various respiratory diseases and complications in anæsthesia.

Spasm of the larynx in connection with anæsthesia may be produced by (1) the direct irritation of the cords by the vapour presented for inhalation, most frequently occurring in the case of ether; (2) by the presence of mucus, blood, pus, or some foreign body, in the larynx itself; (3) by a reflex action as the result of powerful stimulation of peripheral nerves during such manipulations as were shown before to cause reflex deep respirations.

When due to the first-named cause, this difficulty can generally be avoided by introducing the vapour of ether very gradually during the induction of anæsthesia; but if it occur later on, it is wiser to substitute the A.C.E. mixture or chloroform for the former anæsthetic.

Mucus, blood, pus, or any foreign body gaining access to the aperture of the larynx, is best got rid of by allowing the patient to 'come round' far enough to regain his 'coughing reflex,' when such causes of partial laryngeal spasm will probably be expelled by reflex action. Failing this, if the fluid cannot be sponged out, or the substance removed

by the forefinger or a pair of forceps, partial inversion, which is especially easy in children, may succeed in clearing the air tract. Should there then be no relief, tracheotomy is the last resource.

Spasm of the larynx, as the result of powerful stimulation of afferent nerves, is far more marked and inconvenient under chloroform, and, in fact, I personally believe that ether inhibits the transmission of all nerve stimuli more completely than chloroform, and in this manner wards off shock and depression more satisfactorily and for a longer period of time.

A deeper anæsthesia, however, will usually abolish the tendency to 'crowing breathing' or partial laryngeal spasm; but, should it not succeed in doing so, the operator may be asked to desist for a few moments until the respiration has become more tranquil. The cause thus removed, laryngeal spasm will pass off, and after a short interval the narcosis may be gradually deepened before the operation is again attempted.

Distension of the bladder with fluids, and operations on the abdomen above the level of the umbilicus, may be added to the procedures referred to above as a cause of difficulty in breathing from reflex stimulation.

Tumours of the tongue, tonsils, palate, cheeks and gums, nasal polypi and enlarged turbinals are liable to congestion, and increase in size during early stages of anæsthesia, and may thereby involve the airway and obstruct it. The insertion of a short mouth-prop between the teeth prior to the administration will, to a great extent, prevent such an occurrence; but I am of opinion that the patient's posture very largely influences this question, and for operations upon the nose and mouth, would advise that when lying down a patient should be placed with his head well to the side, or even semi-prone; and when sitting up in a chair, that the head should be kept in a line with the body, neither flexed upon the sternum, nor extended backwards, for in these positions a slight tilting of the patient *forwards* will generally suffice to remove any obstruction from the back of the throat. One more pathological condition must be mentioned. Whether due to tympanites, tumours, ascites, or other causes, a patient with a distended abdomen can usually breathe better partly sitting up, and anæsthesia should therefore be gently induced in this position, and thus maintained until distension has been relieved, after which event the supine posture may safely be adopted.

In the comparatively healthy subject, the physical type of patient should be thoroughly recognised beforehand, and in so far as he approaches in appearance to any of the pathological types described, or combines the characteristics of any two or more of them, so should the administrator be prepared for the slight asphyxial factors which, as I have endeavoured to show, may tend in that patient to complicate the induction and maintenance of surgical anæsthesia.

PART II

THE ADMINISTRATION OF NITROUS OXIDE AND OXYGEN, ETHER AND CHLOROFORM, FOR SURGICAL OPERATIONS.

Chapter I

NITROUS OXIDE AND OXYGEN

So many advantages might be claimed for the introduction of an anæsthetic agent which would combine the four attributes of safety, a rapid unconsciousness, muscular relaxation, and freedom from after-effects, that a few remarks on the results which are at present attainable with nitrous oxide gas when mixed with suitable proportions of oxygen may prove of interest as offering the addition to our list of an inhalation less incapacitating than chloroform and ether, but scarcely inferior in value for many surgical procedures of moderate gravity.

The question at once arises, Under what conditions will such an anæsthetic be of special value?

1. A complete examination of the pelvis and abdomen is often needed before a diagnosis can be arrived at in cases which may require ether for an operation shortly afterwards; on these occasions

without any special preparation, gas and oxygen will prove a most convenient help.

2. As ether is very safe, in modern days it is no exception to find patients who have inhaled it several times, but suffer considerably from after-effects; to these the substitution of a tasteless gas during a surgical operation is a great relief.

3. Many operations require some further painful procedure during convalescence—the removal of drainage-tubes, the moving of stiffened joints, the reopening of a wound for hæmorrhage or redressing; for these it is particularly desirable not to upset the patient's digestion by a second dose of ether if nitrous oxide can be made to rise to the occasion.

The apparatus invented by Dr. Frederic Hewitt for use in dental practice is adaptable to surgical cases after a slight enlargement of the oxygen apertures in the mixing chamber, from 10 to 20 per cent. of oxygen being required when the facepiece is kept continuously applied. Such an apparatus has lately been designed by Dr. Hewitt for surgical purposes, and can be obtained from Messrs. Barth and Co. Beginning with 2 or 3 per cent. of oxygen, the patient inspires the gases for five or six breaths, and by means of a dial plate the oxygen is then increased in amount, according to the depth and

rate of breathing, and the colour of the ears and face.

We know exactly the symptoms of asphyxia which nitrous oxide given alone produces—namely, cyanosis, jerky, rapid breathing, twitching of the limbs, and dilated pupils. These objectionable results are avoided by the presence of oxygen, but by means of experience in the use of gas alone the amount of oxygen required in each case is discernible the moment respiration tends to vary at all from that of normal softly snoring sleep. Clinically, if the breathing grows faster and deeper, and colour a trifle dusky, more oxygen is wanted; if quieter and slower, the oxygen must be reduced.

It has been suggested that, in order to obtain elimination for gradually accumulating carbon-dioxide in the blood, it is necessary to cease the administration from time to time and admit atmospheric air. It might be acknowledged, and as a matter of fact I have myself found, that the admission of air is advisable at times during the administration; but not for the purpose of eliminating CO_2 more rapidly than before, because the patient is never rebreathing the gases at any moment of gas and oxygen inhalation, and the CO_2 is, therefore, quite free to pass out from the system at every expiration. The retention of this gas in

the blood is dependent upon its partial pressure in the inspired air, and as there is no CO_2 being inhaled, there is no limit to its elimination.

Any internal asphyxia during the administration of nitrous oxide and oxygen is most probably due to an insufficient proportion of oxygen being administered, and this is the more likely explanation as many writers have found that the anæsthesia of nitrous oxide and oxygen is, on the whole, of a less profound nature than that possible either with ether or chloroform, and that it is often during its use a considerable temptation to the anæsthetist to endeavour to abolish slight muscular reflexes and other inconvenient phenomena by reducing the supply of oxygen and slightly cyanosing the patient.

When discussing the physiological action of anæsthetics as a whole class, it is, of course, possible to conceive that the cells of the brain cortex and spinal cord may be arrested in performing their duties by the chemical contact of the anæsthetic in solution, and that this chemical arrest might even take the form of limiting their power of oxygen absorption and CO_2 elimination.

This, however, if true, is a far more subtle change than the one suggested, and tells no more in favour of one anæsthetic than another.

It is a matter of notoriety that nitrous oxide gas has hardly produced any appreciable mortality at all.

Perhaps, owing to the brevity of its inhalation, or the comparative healthiness of those who have taken it for tooth extraction, or the slight nature of the operations concerned in its use since 1868, the fact remains that by diligent search I can only find accounts (in some cases so fragmentary as to be hardly reliable at all) of eighteen deaths in Europe and America connected with its exhibition. I think that in thirty years of widespread daily administration the total number of inhalations must have amounted to several millions. Even among the recorded fatalities only half can in any strict sense be put down to the nitrous oxide itself, whilst in these probably no other anæsthetic would have afforded less risk.

The two untoward factors due to the presence of nitrous oxide gas without oxygen in the circulation are—(1) the occurrence of concomitant asphyxia (which is, however, readily recognisable before actual danger to life arises); and (2) the rise in blood-pressure, which offers some possibility of cerebral apoplexy in those patients with a degenerated arterial system.

With a view to procuring in surgery a still safer

anæsthetic than ether, I turned my attention to nitrous oxide gas and oxygen for use in surgery.

The obvious fact that, under this anæsthetic, at the moment of removing the facepiece there was no very patent need for doing so, except (the operation being *dental*) to allow the operator to begin, led me to think that we had possibly at hand a great discovery in the direction of applying the mixture to the needs of minor surgical work: for at the acme of what might be termed 'dental' anæsthesia, the patient is sitting upright, breathing through the apparatus in a perfectly normal manner, with a good colour, undilated pupil, and steady pulse; rendered anæsthetic within ninety seconds, and yet needing no immediate 'rescue' by admission of air. What possible accident could occur by continuing the inhalation at the same level and guided by the same symptoms which promised to afford evidences of narcotic influence upon the nervous system almost identical with those of chloroform and ether?

These considerations led me to try the mixture of nitrous oxide and oxygen in cases of tonsil and adenoid extirpation in the Aural Department of Charing Cross Hospital, and the favourable results obtained there during rapid and skilful operations by Mr. Waterhouse led me, after ten months' trial, to

publish a short account of its use in the *Clinical Journal* for September 2, 1896.

The next step was its employment in cases of short operation, which did *not* require removal of the facepiece, tenotomies, passage of catheters, breaking down joint adhesions, incisions of the tympanum, examinations of the pelvic organs, opening and packing of buboes, and such-like rapidly executed manœuvres. In these I generally found that all went well for several minutes until a certain kind of rigidity asserted itself, only abolished by the admission of breaths of air as well as oxygen. These breaths of air at that stage used often to upset the rhythm of respiration, and somewhat impair the subsequent intake of the anæsthetic mixture, and I was glad when the operation was at an end.

On considering what might be the cause of this rigidity, other marked signs of asphyxia being absent, and though not quite convinced that it was not of a reflex nature in operations upon painful and sensitive regions, I came to the conclusion that 10 per cent. of oxygen (the largest amount yielded by Dr. Hewitt's dental apparatus) might be enough in dental cases and other short inhalations, but that possibly a percentage of oxygen more nearly

approaching that present in atmospheric air (namely, 21 per cent.) would be required after all the residual oxygen present in the patient's system, at the moment of the first breath of the mixture, had been expired.

Physiological experiment teaches that, out of the 21 per cent. of oxygen present in ordinary air, only 4·8 per cent. is absorbed, the expirations containing 16·2 per cent. of oxygen. At first sight this would seem to show that a small percentage of oxygen with any indifferent gas would be sufficient to prevent the supervention of asphyxia; but this is not the case. Clinical experience shows that, at any rate in the case of anæsthetic inhalations, the addition of oxygen readily affects the blood aëration, both under ether and nitrous oxide gas.

To obviate, as I thought, all symptoms of asphyxia in these anæsthesias with nitrous oxide gas, a percentage of 15 to 20 of oxygen should be available after the first few minutes' inhalation, and I therefore had the last three apertures in Dr. Hewitt's regulating dial enlarged in diameter, so as to admit the necessary amount to the mixing chamber. This arrangement is all that is necessary to prevent the rigidity which I had previously encountered, and even to supply sufficient oxygen to

bring back consciousness without the admission of any air at all if all the apertures are opened, and the breathing is fairly deep.

That consciousness can be regained after unconsciousness of ten minutes' duration under gas and oxygen by admitting sufficient additional oxygen (and no air) points, perhaps, in the direction that oxygen alone, and no other atmospheric gas, is of much value to the organism in supporting the chemical changes which constitute the life of the nerve cell. In the *Lancet* for June 12, 1897, I published an account, with illustrative cases, of what had then been accomplished, the longest administration then attempted lasting fourteen minutes. I continued using the mixed gases, chiefly in private practice, and gave a further account in the *British Gynæcological Journal* for August, 1897, of several operations for which it had proved an exceedingly satisfactory anæsthetic. These included the incision into a large mammary abscess, with subsequent curettage and swabbing out with antiseptics, lasting seven minutes; the excision of an almost imperforate hymen, lasting eight minutes; and an abdominal exploration for diagnostic purposes: in all three cases no after-effects at all being observed.

After this instances were recorded of its successful application for the removal of a cystic adenoma of the breast, lasting twenty minutes, dilatation of the cervix uteri for fifteen minutes, reopening of a lumbar renal incision during sixteen minutes. These I alluded to in an article in the *British Medical Journal* for April 30, 1898. Since then I have notes of longer cases still, two of twenty-five minutes' duration (exploration for necrosis of the femur, and excision of varicose veins in the leg), besides a very large number of excellent anæsthesias, ranging from five to twenty minutes.

The following are the opinions formed after the use of the mixed gases in surgical operations: The *circulation* is well maintained, the pulse being regular and full, never slow as under chloroform, but with only a tendency to increased frequency when asphyxial factors are allowed to arise. The *breathing* is like that under the A.C.E. mixture, not so stertorous or forcible as ether respiration, nor so quiet as that of chloroform. The *lid reflex* is very slight in good anæsthesia, but is not quite abolished without some tendency to the use of too little oxygen. The pupil tends to become moderately contracted, varying inversely as the proportion of oxygen be small or large. The actual anæsthesia is not so

profound as that obtained by chloroform and ether—that is, although operations upon the most sensitive spots will not give the patients sensations of *pain*, there will be certain reflexes excited in adjacent limbs, or in the respiratory mechanism, which cannot be abolished completely under the influence of the mixture. Rectal operation will cause movement or rigidity of the legs in some people, and urethral dilatation has the same effect. In many persons abdominal relaxation can be attained, especially if the patient is made to lie on the side while, for instance, pelvic examination is being carried on. Retching movements and sickness cannot be controlled by more gas and oxygen, as with other anæsthetics; this is a great drawback, and negatives the value of the mixture in boys and girls, about ten to fifteen years of age, who seem somewhat prone to sickness. Coughing I have not met with. Profuse sweating is very common, and sometimes there is a lowering of skin-surface temperature. After-effects are commonly absent, and consciousness is usually regained within three minutes of discontinuing the inhalation. Drowsiness is not present afterwards, most patients feeling quite fresh and clear in the head after even a quarter of an hour's anæsthesia. If nausea *be* excited, I con-

sider it is of rather a persistent type. Florid, alcoholic, and very muscular men are not such good subjects as the more ordinary type, nor can it be recommended for small children.

I have tried gas and oxygen largely at the National Orthopædic Hospital on children of two years and upwards. In those under five years prolonged inhalation seems not only totally unsuitable, but positively dangerous, for the following reasons: In healthy children all reflexes seem to be more easily excited than in adults; effects of heat and cold, injury and shock, are far more pronounced. The nervous system is not so thoroughly under the control of the higher centres, nor, as it were, has the respiratory regulator in the medulla yet become so independent of afferent external impressions. The result is that we find, under chloroform and ether, high-pitched laryngeal crowing, caused by reflex spasm in rectal, genito-urinary, and other operations; and under the slightly less profound anæsthesia of nitrous oxide and oxygen we find a spasm of the respiratory muscles of the chest wall and larynx, bringing the breathing to a standstill even in much less painful procedures. This, if it occurs, makes it absolutely necessary to stop the operation, or the spasm will not depart. If

this be *not* done, and one simply waits for the next breath, pallor supervenes very rapidly, and, the pulse failing secondarily, a very alarming syncope results. I am speaking of quite small children. It has happened to me on three occasions, and has threatened in others.

Now as to the administration itself. An average adult, breathing 25 to 30 cubic inches of gas at each respiration—say twenty times a minute—will require 9,000 cubic inches, or nearly 40 gallons every quarter of an hour. Two 50-gallon bottles of gas and one 24-gallon bottle of oxygen will be required for a half-hour's operation. The three bottles are very heavy to carry, and the actual cost of the gases used will be ten shillings at the least, even in London.

To obtain anything approaching accuracy in the percentage proportion of the mixture, the double gas-bag of Dr. Hewitt's apparatus must *hang free of the couch*, and must not rest upon a bed or pillow, because in that event its own weight will force unknown proportions of oxygen through the apertures. The patient must be first of all placed in the exact position which is needed for the operation, for no movement of the head and shoulders can be permitted after commencing the

administration, or else the position of the bag will be interfered with, and the anæsthetist's control of the foot-keys will be imperfect. In fact, everything is upset by moving the patient's position after starting, regular rhythm of breathing being a very important factor.

The actual administration, in my opinion, requires more skill and experience of the significance of slight alterations in colour and breathing than the other anæsthetics, and I do not anticipate that its possibilities are very large, as they are limited by (1) the production of only a moderately profound anæsthesia, with tendencies to muscular rigidity and reflexes; (2) its unsuitability for young children. On the other hand, as an addition to our resources for examination of the pelvis in gynæcological work, for those who are about to take ether a few days after for a major operation, and in selected subjects during operations lasting, say, ten to fifteen minutes, it fulfils every requirement.

Since the beginning of the year 1895 I have used the mixture almost exclusively in *dental* cases, and proceeding exactly according to the directions formulated by Dr. Hewitt, I have now, with an experience of several thousand administrations, the following observations to record: The anæsthesia

is complete, tranquil, not unpleasant to witness, sufficiently long for the extraction of about three ordinary teeth without any pain or bad dreams. The sensations produced by its inhalation are often exhilarating, and never dreaded a second time.

The administration is best conducted by using the respiration as the *chief* guide.

Commencing with nitrous oxide and 2 per cent. of oxygen, we should wait until, after five or six breaths, a rather deeper breathing sets in; then increase to 4 per cent., then to 6 per cent. or 8 per cent. of oxygen, according to the type of patient, aiming to produce audible normal respiration. If the breathing be deeper than this, we increase the oxygen till it is attained; if more shallow, we decrease the oxygen, to produce the same result, remembering, however, that good anæsthesia always takes time (one and a half to two minutes, sometimes longer) to produce.

Soft snoring, if the head be neither flexed nor extended, is an excellent indication to begin the operation, but I regard the eyes as affording the most invariable and reliable symptom of complete insensibility. The eyeballs converge and look downwards after slight preliminary vertical nystagmus, the pupils being partially contracted, as in natural sleep.

Now this can be observed without testing the conjunctival reflex, for the eyelids are generally open or half open at the time; the lid reflex will, however, be found 'sluggish,' if not quite in abeyance.

Next, as to returning consciousness. Sight and hearing return before sensation to pain; therefore watch the eye if open, or elevate the lid. When voluntary movement of the eye in 'looking round' occurs, you must immediately warn the operator to stop. This will, without exception, never fail to prevent tranquillity being mistaken for anæsthesia.

I have seen only two patients nearly faint under its influence, but both were subject to such attacks on slight excitement, and I do not think the anæsthetic had any primary influence upon them. Some boys are sick after gas and oxygen; they often eat largely and bolt their food. Perhaps, having had toothache, they have not been able to bite even as much as usual. Undigested food in the stomach is, I think, most frequently the cause.

If, as I suggest, too many teeth are not attempted at a time, gas and oxygen for *dental* operations has no other detractions. It is as nearly a perfect anæsthetic, and as safe, as could be desired by dentist or anæsthetist.

Chapter II

ETHER

A Clover's portable ether-inhaler, constructed in such a manner that no feeling of dyspnœa is perceptible when it is breathed into with the indicator either at 0, 1, 2, 3, or 4, is the best instrument in the hands of the general practitioner for producing ether anæsthesia. In choosing one from a good maker, this matter of a really free channel for respiration is of the greatest importance, for even a slight mechanical obstruction begins to cause laboured breathing and cyanosis if it acts for a sufficient length of time.

The fit of the facepiece is the next most necessary consideration. It will very seldom be necessary to use a large facepiece (except in dental cases with the mouth propped open). Two facepieces, one of medium size, and another very small one, for children and young people, should be procured.

The use of these will produce a much greater success in the ordinary run of cases, owing to leakage of air under the rim of a large one interfering with profound anæsthesia. The cylindrical part of the ether-inhaler round which the indicator travels is a hermetically-sealed chamber containing water, which latter can be heard splashing inside if the instrument be shaken; this noise is, therefore, no indication that the inhaler contains ether, as, it seems, is often erroneously supposed.

The ether chamber itself, which is spherical, will hold 1½ ounces of ether, and its orifice should have a vulcanite stopper fitted with a little glass bulb, so that the amount of contained ether can be estimated at any time if the instrument be held vertical.

Whenever the atmosphere is at all cool in the operating room, the cylindrical part of the inhaler should be immersed in warm water (about 80° F.) for a minute or two before use; this will cause the ether, which is afterwards poured in, to evaporate more evenly than if the inhaler be left cold. Water parts with its specific heat slowly, and will maintain the liquid ether at a temperature nearer to its boiling-point, *i.e.*, one more favourable to evaporation.

The proper sized facepiece is then chosen and fixed on to the shaft of the ether inhaler; the little

slot in the metal band of the facepiece is to be passed home around the base of the dial indicator, otherwise the facepiece is apt to revolve without working the apparatus.

Messrs. Barth and Co., of Poland Street, Soho, have lately made a pattern of Clover's inhaler which, in addition to other advantages, has an internal breathing shaft passing straight through the instrument, the facepiece being adjusted to one end of it and the inhaling-bag to the other; when the ether chamber is gradually made to revolve upon this shaft, the bag does not become inverted, but retains its original relation to the facepiece. This is unlike the older pattern of the inhaler with a half-shaft of whistle shape, which has the drawback of occasionally coming partly out of its sheath and also of allowing the neck of the bag to kink when the ether is turned on.

To fill the ether chamber, it will be found best to turn the indicator towards the mark 1, as the liquid ether passes in more readily when air can escape from the internal slots partly opened by this movement.

Twelve drachms of ether having been introduced, the inhaler should be held in whichever hand is most convenient to the administrator and for the

purposes of the operation; supposing the right breast is to be excised, the patient's face should be turned to the left, and the metal hemisphere should lie in the palm of the anæsthetist's left hand. The warmth of the hand is of use in maintaining the ether at a proper temperature, and the finest movements in regulating the strength of ether vapour can be made by the fingers and thumb upon the revolving hemisphere.

Next, the anæsthetist, making sure there is no smell of ether in the facepiece, should adjust the latter to cover the patient's nose and mouth; turning the head well to the side, the third and fourth fingers of his free hand should lie below the patient's chin, his first and second fingers supporting the facepiece against the lower cheek, whilst his thumb compresses the facepiece against the upper cheek. In this way the slightest swallowing movements, and any alteration in the respiratory rhythm, can be appreciated by the little fingers, which also, during anæsthesia, elevate the chin to prevent the tongue falling back against the pharyngeal wall.

The patient is now asked to breathe slowly 'in and out through the mouth,' and, after a few reassuring remarks from the administrator, the inhaling-bag may be adjusted and filled nearly full with the

patient's expirations. This is done by raising the facepiece slightly (at its lower end only) during inspiration, and lowering it again during the next expiration. This little manœuvre can be easily practised by the student upon himself with an empty inhaler. The necessary skill to effect this will soon be acquired, and the method is far more sanitary than the common one of blowing the bag up one's self and then allowing the patient to breathe the resulting contents of the inhaler.

The facepiece is closely adjusted, and the bag now being nearly full, *but not distended*, the patient should *breathe to and fro five times* before any ether is admitted; the administrator now very gradually rotates the hemisphere about one-sixteenth of an inch at every expiration, proceeding steadily as long as the patient breathes quite freely, the slightest swallowing or holding of the breath being met by stopping the revolution, or even turning back a little way to decrease the pungency of the vapour.

The respirations will gradually increase in depth and force, and the indicator generally can be worked up to 1½ before any air need be admitted, but the latter should (when required by any cyanotic appearances) be given during an inspiration, the following expiration being caught by the adminis-

trator in the inhaling-bag. Proceeding gradually in the same way, when 'slight stertor' is heard, a breath of air at every fifth inspiration may be given, and also throughout the subsequent administration. If the patient's head is kept *on the side* throughout, mucus which is secreted does not run back into the fauces and cause cough and other straining movements, and the anæsthetist, keeping his left wrist and arm upon the upper side of the patient's head, can, by pressing downwards, also effectually control efforts at movement on the part of any restless subject during the second or 'excitement' stage.

It should never be anticipated that any patient is properly flaccid or beyond the possibility of reflex movement until the lapse of five minutes from the first breath of ether, nor, on the other hand, should the induction take more than ten minutes at the longest.

Surgical anæsthesia with good colour, deep, regular respiration and a sluggish lid reflex should be attained within about five to seven minutes; otherwise the second stage, in which excitement, swallowing, vomiting, coughing, and rigidity, with holding of the breath, and all sorts of difficulties, is prolonged with no possible benefit to patient or surgeon.

No patient should be allowed to vomit *at all* in passing into anæsthesia. It is a sign of too little anæsthetic having been given, and can *always* be avoided by skilfully and gradually increasing the strength of the vapour.

The most common mistake made by all unpractised administrators is to neglect to make the facepiece fit absolutely, to the exclusion of any air at all; however, this should be done except at every fifth breath, which it is *intended* should be taken from the atmosphere.

The first ounce and a half of ether will, as a rule, last for the first ten minutes of anæsthesia, but the quantity expended depends largely on the type and size of the patient. The more bulky and plethoric the subject, the greater will be the dose of ether required to attain complete anæsthesia. Whilst a small woman may be kept completely under, perhaps, for ten to fifteen minutes with the first-mentioned quantity, a full-sized man may even require another ounce of ether poured in before he is ready for operation. When fresh ether is added, the indicator should be put back to nearly 0, in order to prevent the coughing which might be set up by a sudden strong vapour of ether; and it will also

be found of advantage whenever the inhaler has been removed to carefully readjust the facepiece during an expiration, in order to again fill the bag and also partly warm the contained vapour before it is inspired.

Chapter III

CHLOROFORM

It is for many reasons advisable to use a chloroform mask in all cases in preference to a piece of lint or towel end, because the latter may come in contact with the patient's face and blister it, when wet with the fluid anæsthetic.

Skinner's wire frame, covered with one thickness of ordinary flannel, is the best mask, and Thomas's 2-ounce chloroform drop-bottle should be procured for pouring the liquid upon it.

Beside these simple instruments, a tongue forceps with catch, a Mason's mouth-gag, a short wooden wedge for insertion between clenched teeth, and tracheotomy instruments, are vital accessories at every administration. No food should be allowed the patient for four hours beforehand, and the last meal should consist of semi-fluids only.

The patient should always be placed in the horizontal position, preferably on his back, with the head low and turned to one side.

Three portions of the patient's system should be examined before giving the anæsthetic—the upper air-passages, the lungs, and the circulation.

First open the mouth and look inside it for loose teeth, in order that these may not be dislodged by the insertion of a gag or other subsequent manipulations. Any artificial teeth on *small* plates should be removed, but a complete upper or lower set is best left in place, because some respiratory obstruction is apt to arise during narcosis from the close approximation of the tongue and palatal structures. Observe also whether nasal breathing is free, and listen to the respiration to detect tonsillar, laryngeal, or tracheal obstructions.

Place your hands upon the patient's chest and tell him to breathe freely; any impairment in mobility of the chest walls should put you on your guard for pathological conditions within the thorax, and you should, if these be suspected, listen carefully to the respiratory sounds, both in front and behind, with the stethoscope. If it be found that less than the equivalent of one lung is working properly, do not give a general anæsthetic at all.

Feel both radial pulses to determine their force and regularity. You will thus be better able to estimate changes in the circulation during the anæsthesia. It is also wise, if there should be any suspicion of cardiac valvular incompetence, to acquaint yourself with its nature and extent, as it will be well if there should be disease to use an open method of producing anæsthesia, and to take especial care that no asphyxial element, however slight, shall be admitted during the narcosis.

In conducting the administration, turn the patient's head to the right side, if this position be suitable for the operation, and rest your left arm lightly upon the left side of his head with the palmar margin of your left hand and little finger supporting his lower jaw, the Skinner's mask (dry) being held between the other fingers and thumb of that hand half an inch from the patient's face, so as to cover his nose and mouth. Now tell the patient to breathe *slowly* 'in and out through the mouth,' or tell a child to close his eyes and 'blow the scent away,' and from the drop-bottle held in your right hand drop first a few drops of chloroform upon the outer and upper surface of the flannel mask *opposite the patient's mouth, not* near his eyes; then, very carefully watching its effect upon his respiration,

continue dropping on chloroform until a patch of flannel about the size of a penny is wet with it. Stop adding chloroform for a few seconds whenever there is any holding of the breath until respiration is again regular.

Keep on telling the patient to 'blow in and out,' increasing the size of the wet patch to that of two pennies.

The patient's consciousness is now disordered; he is probably swallowing at intervals, and may attempt to move about; your best plan, therefore, is to bear slightly with your left arm and wrist upon the left side of his head, and thereby effectually prevent any alteration in his posture. If an adult patient holds his breath, or if a child cries at this stage, hold the mask away from his face for the very deep inspiration which immediately follows, then replace the mask and proceed as before, keeping a patch of the flannel always wet with chloroform. Regular automatic respiration with muscular flaccidity will soon supervene.

No patient should be sick in passing under the influence of chloroform, for if the vapour be gradually and steadily increased as indicated, the vomiting centre will be narcotized without giving time for nausea or retching to occur.

The patient should be ready for operation in six to eight minutes from the beginning of the inhalation —in no case longer.

When automatic respiration, in which expiration is quite free and without hitch of any kind, is first heard, the patient's corneal reflex should be tested in order to discover the exact depth of anæsthesia.

To do this, the middle finger of your right hand should gently elevate the margin of the patient's upper eyelid, and as your finger pulp passes over the cornea it should be allowed to lightly brush against it ; the finger then leaves go, and according to the degree of anæsthesia the lid shuts either briskly or sluggishly for the second or third stage of anæsthesia respectively.

This corneal reflex should not be abolished altogether, but kept acting slightly throughout the administration.

The art of inducing chloroform anæsthesia is that of verbally encouraging the patient to breathe slowly and regularly until the unconsciousness sets in. The art of maintaining chloroform anæsthesia is that of regulating the respiration to a uniform level throughout the administration.

Chapter IV

THE TRANSFER OF A PATIENT FROM BED TO THE OPERATING-TABLE

With the object of formulating some kind of rule for the efficient transfer of patients from bed to the operating-table, the writer of these notes published the following letter in the *British Medical Journal* for April 28, 1900:

The administration of an anæsthetic must be regarded as an art, in which, as in every branch of surgery and other arts, perfect facility is only attainable by constant, long-continued, careful practice.

A smooth performance is the outcome of very careful forethought and appropriate training, and the minutest details of procedure must be considered in order to gain success.

The moving of a patient from his bed to the

operating-table often requires a little strategy, even when both bed and table are close together in one room. Those who lift a patient should never stand on opposite sides of his body, for two reasons: (1) Because the lifters take up too much space to pass through doorways or easily traverse an ordinary furnished bedroom; and (2) because the lifting power is much greater when the patient's body can be held close up to the lifter—that is, when the latter can bring his feet beneath the centre of gravity of his own body and the lifted weight.

Two persons standing side by side can lift almost any ordinary patient, one supporting the weight of his head, shoulders, and back, and the other that of his pelvis and legs. The head-lifter should pass one hand beneath the patient's shoulders and grasp the further arm above the elbow, allowing the patient's head to rest upon his own biceps. He should pass his other hand and arm beneath the patient's back, whilst the foot-lifter takes the pelvis and legs. They then both raise the body up to the level of their own chests and walk sideways to the operating-table.

The position of the table with regard to the bed is the point which is often unconsidered. The rule should be the following: Place the foot of

the table towards the head of the bed at a right angle to it, or the head of the table towards the foot of the bed at a right angle to it; lift the patient and then move the table into position. The lifters, standing within the angle formed, will only need to turn a quarter-circle in order to deposit the patient upon the table. Now, this rule, 'Head towards foot at a right angle,' holds good even when the bed and table are not close together, but separated by a long interval.

It will be seen that by this method, even after carrying a patient from one room to another, the lifters will arrive at the proper side of the table, and then, by making a quarter-turn, they will complete the movement of the patient. What could be more awkward than the bungling of a patient from table to bed if these are placed side by side? In that case, if the lifter stands between the bed and the table, he either himself arrives upon the bed with the patient's body on his lap, or, if a half-turn be made, the patient's head arrives at the foot end of the bed. By another bad method, the feet and the shoulders are seized by persons at either end, and the patient may drop to the floor while they shuffle him laterally from one couch to the other.

When an operation is just completed, supposing

the table to be at right angles to the bed, and its head towards the head of the bed, all that is needed to avoid the lifters being in their own way is to turn the table parallel to the bed, with 'head to foot,' a clear space being left between the two; by lifting the patient through a half-circle turn the movement will be completed.

It will be seen, then, from the foregoing account that 'bed and table—head to foot, at a right angle,' involves only a quarter-circle turn of the patient, and 'bed and table—head to foot—parallel,' with a clear space between them, involves simply a half-circle turn of the patient.

As a rule, if a patient has to be carried up a winding staircase or any distance, a stretcher or carrying-chair is used, and to the stretcher I do not refer, except to recommend that the 'feet up' position should always be adopted in carrying a partly anæsthetized patient up and down stairs, for two reasons—(1) that any vomited matter cannot then be inhaled into the trachea, and (2) that the force of gravity acting upon the patient's circulation when thus carried prevents faintness from cerebral anæmia.

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